<110> YAMAMOTO, Takuo
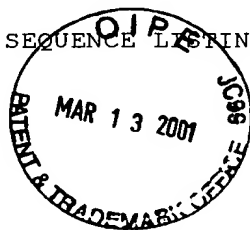   MARUTA, Kazuhiko
      KUBOTA, Michio
      FUKUDA, Shigeharu
      MIYAKE, Toshio

<120> NON-REDUCING SACCHARIDE-FORMING ENZYME,
      TREHALOSE-RELEASING ENZYME, AND PROCESS FOR PRODUCING
      SACCHARIDES USING THE ENZYMES

<130> YAMAMOTO=16A

<140> 09/435,770
<141> 1999-11-08

<150> JP 258,394/1998
<151> 1998-09-11

<150> JP 352,252/1998
<151> 1998-12-11

<150> JP 16,931/1999
<151> 1999-01-26

<160> 39

<170> PatentIn Ver. 2.1

<210> 1
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Leu Tyr Leu Ser Pro Leu Leu Glu Ser Glu Ser Gly Ser Ser His Gly
         35                  40                  45

Tyr Asp Val Val Asp His Ser Arg Val Asp Ala Ala Arg Gly Gly Pro
     50                  55                  60

Glu Gly Leu Ala Glu Leu Ser Arg Ala Ala His Glu Arg Gly Met Gly
 65                  70                  75                  80

Val Val Val Asp Ile Val Pro Asn His Val Gly Val Ala Thr Pro Lys
                 85                  90                  95

Ala Asn Arg Trp Trp Trp Asp Val Leu Ala Arg Gly Gln Arg Ser Glu
                100                 105                 110

Tyr Ala Asp Tyr Phe Asp Ile Asp Trp Glu Phe Gly Gly Gly Arg Leu
         115                 120                 125
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    130              135          140
Val Asp Gly Asp Glu Leu Val Tyr Tyr Glu His Arg Phe Pro Ile Ala
145              150          155              160
Glu Gly Thr Gly Gly Gly Thr Pro Arg Glu Val His Asp Arg Gln His
                165          170              175
Tyr Glu Leu Met Ser Trp Arg Arg Ala Asp His Asp Leu Asn Tyr Arg
            180          185              190
Arg Phe Phe Ala Val Asn Thr Leu Ala Ala Val Arg Val Glu Asp Pro
        195          200              205
Arg Val Phe Asp Asp Thr His Arg Glu Ile Gly Arg Trp Ile Ala Glu
    210          215              220
Gly Leu Val Asp Gly Leu Arg Val Asp His Pro Asp Gly Leu Arg Ala
225              230              235              240
Pro Gly Asp Tyr Leu Arg Arg Leu Ala Glu Leu Ala Gln Gly Arg Pro
            245              250              255
Ile Trp Val Glu Lys Ile Ile Glu Gly Asp Glu Arg Met Pro Pro Gln
            260              265              270
Trp Pro Ile Ala Gly Thr Thr Gly Tyr Asp Ala Leu Ala Gly Ile Asp
        275              280              285
Arg Val Leu Val Asp Pro Ala Gly Glu His Pro Leu Thr Gln Ile Val
    290              295              300
Asp Glu Ala Ala Gly Ser Pro Arg Arg Trp Ala Glu Leu Val Pro Glu
305              310              315              320
Arg Lys Arg Ala Val Ala Arg Gly Ile Leu Asn Ser Glu Ile Arg Arg
            325              330              335
Val Ala Arg Glu Leu Gly Glu Val Ala Gly Asp Val Glu Asp Ala Leu
            340              345              350
Val Glu Ile Ala Ala Ala Leu Ser Val Tyr Arg Ser Tyr Leu Pro Phe
            355              360              365
Gly Arg Glu His Leu Asp Glu Ala Val Ala Ala Ala Gln Ala Ala Ala
    370              375              380
Pro Gln Leu Glu Ala Asp Leu Ala Ala Val Gly Ala Ala Leu Ala Asp
385              390              395              400
Pro Gly Asn Pro Ala Ala Leu Arg Phe Gln Gln Thr Ser Gly Met Ile
            405              410              415
Met Ala Lys Gly Val Glu Asp Asn Ala Phe Tyr Arg Tyr Pro Arg Leu
            420              425              430
Thr Ser Leu Thr Glu Val Gly Gly Asp Pro Ser Leu Phe Ala Ile Asp
            435              440              445
Ala Ala Ala Phe His Ala Ala Gln Arg Asp Arg Ala Ala Arg Leu Pro
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```
         450                    455                    460

Glu Ser Met Thr Thr Leu Thr Thr His Asp Thr Lys Arg Ser Glu Asp
465             470             475                     480

Thr Arg Ala Arg Ile Thr Ala Leu Ala Glu Ala Pro Glu Arg Trp Arg
            485             490                     495

Arg Phe Leu Thr Glu Val Gly Gly Leu Ile Gly Thr Gly Asp Arg Val
            500             505             510

Leu Glu Asn Leu Ile Trp Gln Ala Ile Val Gly Ala Trp Pro Ala Ser
            515             520             525

Arg Glu Arg Leu Glu Ala Tyr Ala Leu Lys Ala Ala Arg Glu Ala Gly
    530             535             540

Glu Ser Thr Asp Trp Ile Asp Gly Asp Pro Ala Phe Glu Glu Arg Leu
545             550             555                     560

Thr Arg Leu Val Thr Val Ala Val Glu Glu Pro Leu Val His Glu Leu
            565             570             575

Leu Glu Arg Leu Val Asp Glu Leu Thr Ala Ala Gly Tyr Ser Asn Gly
            580             585             590

Leu Ala Ala Lys Leu Leu Gln Leu Leu Ala Pro Gly Thr Pro Asp Val
            595             600             605

Tyr Gln Gly Thr Glu Arg Trp Asp Arg Ser Leu Val Asp Pro Asp Asn
    610             615             620

Arg Arg Pro Val Asp Phe Ala Ala Ala Ser Glu Leu Leu Asp Arg Leu
625             630             635                     640

Asp Gly Gly Trp Arg Pro Pro Val Asp Glu Thr Gly Ala Val Lys Thr
            645             650             655

Leu Val Val Ser Arg Ala Leu Arg Leu Arg Arg Asp Arg Pro Glu Leu
            660             665             670

Phe Thr Ala Tyr His Pro Val Thr Ala Arg Gly Ala Gln Ala Glu His
    675             680             685

Leu Ile Gly Phe Asp Arg Gly Gly Ala Ile Ala Leu Ala Thr Arg Leu
    690             695             700

Pro Leu Gly Leu Ala Ala Ala Gly Gly Trp Gly Asp Thr Val Val Asp
705             710             715             720

Val Gly Glu Arg Ser Leu Arg Asp Glu Leu Thr Gly Arg Glu Ala Arg
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Gly Ala Ala Arg Val Ala Glu Leu Phe Ala Asp Tyr Pro Val Ala Leu
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Leu Val Glu Thr
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 1   5

<210> 4
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Pro Ala Ser Thr Tyr Arg Leu Gln Ile Ser Ala Glu Phe Thr Leu Phe
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Asp Ala Ala Arg
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Ser Leu Val Asp Pro Asp Asn Arg Arg Pro Val Asp Phe Ala Ala Ala
 1   5   10   15

Ser Glu Leu Leu
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<210> 6
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Ala Asn Arg Trp Trp Trp Asp Val Leu Ala Arg Gly Gln Arg Ser Glu
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Tyr Ala Asp Tyr
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<213> ARTHROBACTER sp.S34

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tccgagtcgg gctcctcgca cggctacgac gtggtcgacc actcccgcgt cgacgccgcc  180
cgcggcgggc cggagggct cgccgagctc tcccgtgcgg cgcacgagcg cggcatgggc  240
gtcgtcgtcg acatcgtgcc caaccacgtc ggcgtcgcga cgccgaaggc gaaccgctgg  300
tggtggggacg ttctggcccg tggacagcgg tcggagtacg ccgactactt cgacatcgac  360
tgggagttcg cggcggcag gctgcgcctg cccgtgctcg cgacggccc cgacgagctc  420
gacgcgctga gagtggatgg cgacgagctc gtctactacg agcaccgctt cccgatcgcc  480
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tcgtggcggc gggccgacca cgacctcaac taccgccgct tcttcgccgt gaacacgctc  600
gccgccgtac gcgtcgaaga cccgcgcgtg ttcgacgaca cccaccgcga gatcggccgc  660
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cccggcgact acctgcgccg tctcgccgag ctcgcccaag gcaggccgat ctgggtcgag  780
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28
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<400> 9
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Leu Val Val Gly Gln Gly Arg Ala Glu Leu Pro Leu Thr Arg Asp Glu
```

5126

```
                    20                    25                    30

Asn Gly Trp Trp Ala Leu Gln Gln Pro Trp Asp Gly Gly Pro Asp Leu
        35                    40                    45

Val Asp Tyr Gly Tyr Leu Val Asp Gly Lys Gly Pro Phe Ala Asp Pro
        50                    55                    60

Arg Ser Leu Arg Gln Pro Arg Gly Val His Glu Leu Gly Arg Glu Phe
 65                    70                    75                    80

Asp Pro Ala Arg Tyr Ala Trp Gly Asp Asp Gly Trp Arg Gly Arg Asp
                85                    90                    95

Leu Thr Gly Ala Val Ile Tyr Glu Leu His Val Gly Thr Phe Thr Pro
            100                   105                   110

Glu Gly Thr Leu Asp Ser Ala Ile Arg Arg Leu Asp His Leu Val Arg
            115                   120                   125

Leu Gly Val Asp Ala Val Glu Leu Leu Pro Val Asn Ala Phe Asn Gly
            130                   135                   140

Thr His Gly Trp Gly Tyr Asp Gly Val Leu Trp Tyr Ala Val His Glu
145                   150                   155                   160

Pro Tyr Gly Gly Pro Glu Ala Tyr Gln Arg Phe Val Asp Ala Cys His
                165                   170                   175

Ala Arg Gly Leu Ala Val Val Gln Asp Val Val Tyr Asn His Leu Gly
            180                   185                   190

Pro Ser Gly Asn His Leu Pro Asp Phe Gly Pro Tyr Leu Gly Ser Gly
            195                   200                   205

Ala Ala Asn Thr Trp Gly Asp Ala Leu Asn Leu Asp Gly Pro Leu Ser
    210                   215                   220

Asp Glu Val Arg Arg Tyr Ile Ile Asp Asn Ala Val Tyr Trp Leu Arg
225                   230                   235                   240

Asp Met His Ala Asp Gly Leu Arg Leu Asp Ala Val His Ala Leu Arg
                245                   250                   255

Asp Ala Arg Ala Leu His Leu Leu Glu Glu Leu Ala Ala Arg Val Asp
            260                   265                   270

Glu Leu Ala Gly Glu Leu Gly Arg Pro Leu Thr Leu Ile Ala Glu Ser
            275                   280                   285

Asp Leu Asn Asp Pro Lys Leu Ile Arg Ser Arg Ala Ala His Gly Tyr
            290                   295                   300

Gly Leu Asp Ala Gln Trp Asp Asp Asp Val His His Ala Val His Ala
305                   310                   315                   320

Asn Val Thr Gly Glu Thr Val Gly Tyr Tyr Ala Asp Phe Gly Gly Leu
                325                   330                   335

Gly Ala Leu Val Lys Val Phe Gln Arg Gly Trp Phe His Asp Gly Thr
            340                   345                   350
```

```
Trp Ser Ser Phe Arg Glu Arg His His Gly Arg Pro Leu Asp Pro Asp
    355                 360             365
```

```
Ile Pro Phe Arg Arg Leu Val Ala Phe Ala Gln Asp His Asp Gln Val
    370             375             380
```

```
Gly Asn Arg Ala Val Gly Asp Arg Met Ser Ala Gln Val Gly Glu Gly
385                 390             395                 400
```

```
Ser Leu Ala Ala Ala Ala Ala Leu Val Leu Leu Gly Pro Phe Thr Pro
                405             410             415
```

```
Met Leu Phe Met Gly Glu Glu Trp Gly Ala Arg Thr Pro Trp Gln Phe
            420             425             430
```

```
Phe Thr Ser His Pro Glu Pro Glu Leu Gly Glu Ala Thr Ala Arg Gly
            435             440             445
```

```
Arg Ile Ala Glu Phe Ala Arg Met Gly Trp Asp Pro Ala Val Val Pro
    450             455             460
```

```
Asp Pro Gln Asp Pro Ala Thr Phe Ala Arg Ser His Leu Asp Trp Ser
465             470             475             480
```

```
Glu Pro Glu Arg Glu Pro His Ala Gly Leu Leu Ala Phe Tyr Thr Asp
            485             490             495
```

```
Leu Ile Ala Leu Arg Arg Glu Leu Pro Val Asp Ala Pro Ala Arg Glu
            500             505             510
```

```
Val Asp Ala Asp Glu Ala Arg Gly Val Phe Ala Phe Ser Arg Gly Pro
            515             520             525
```

```
Leu Arg Val Thr Val Ala Leu Arg Pro Gly Pro Val Gly Val Pro Glu
    530             535             540
```

```
His Gly Gly Leu Val Leu Ala Tyr Gly Glu Val Arg Ala Gly Ala Ala
545                 550             555                 560
```

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Gly Leu His Leu Asp Gly Pro Gly Ala Ala Ile Val Arg Leu Glu
            565             570             575
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<210> 11
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<210> 12
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Arg Leu Asp Ala Val His Ala
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<210> 13
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<210> 14
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Leu Val Val Gly
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<212> PRT
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Ser Arg Ala Ala His Gly Tyr Gly Leu Asp Ala Gln Trp Asp Asp Asp
 1   5   10   15

Val His His Ala
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<210> 16
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<212> PRT
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<400> 16
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Asp Leu Val Asp
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ccgtgggacg gcggccccga cctcgtcgac tacggctacc tcgtcgacgg caagggcccc     180
ttcgccgacc cgcggtcgct gcggcagccg cgcggcgtgc acgagctcgg ccgcgaattc     240
gaccccgccc gctacgcgtg gggcgacgac ggatggcgcg gccgagacct caccggagcc     300
gtgatctacg aactgcacgt cggcaccttc acccctgagg gaacgctgga cagcgccatc     360
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gcgttcaacg gcacccacgg ctggggctac gacggggtgc tctggtacgc ggtgcacgag     480
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gccgtcgtgc aggacgtcgt ctacaaccac ctgggcccga gcggcaacca cctgcccgac     600
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ggggtgcccg agcacggggg cctcgtgctc gcctacggcg aggtgcgcgc cggcgccgcc    1680
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<210> 18
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<400> 18
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<212> DNA
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<400> 19

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gcacctgcgt agattcggcc tc gtg ccc gcc agt acc tac cgc ctt cag atc     772
                         Met Pro Ala Ser Thr Tyr Arg Leu Gln Ile
                          1               5                  10
```

```
tcg gcg gag ttc acc ctc ttc gac gcg gcg cgc atc gtg ccc tac ctg      820
Ser Ala Glu Phe Thr Leu Phe Asp Ala Ala Arg Ile Val Pro Tyr Leu
                 15                  20                  25
```

```
cac cgc ctc ggc gcc gac tgg ctg tac ctc tcg ccg ctg ctc gag tcc      868
His Arg Leu Gly Ala Asp Trp Leu Tyr Leu Ser Pro Leu Leu Glu Ser
                 30                  35                  40
```

```
gag tcg ggc tcc tcg cac ggc tac gac gtg gtc gac cac tcc cgc gtc      916
Glu Ser Gly Ser Ser His Gly Tyr Asp Val Val Asp His Ser Arg Val
                 45                  50                  55
```

```
gac gcc gcc cgc ggc ggg ccg gag ggg ctc gcc gag ctc tcc cgt gcg      964
Asp Ala Ala Arg Gly Gly Pro Glu Gly Leu Ala Glu Leu Ser Arg Ala
     60                  65                  70
```

```
gcg cac gag cgc ggc atg ggc gtc gtc gtc gac atc gtg ccc aac cac     1012
Ala His Glu Arg Gly Met Gly Val Val Val Asp Ile Val Pro Asn His
 75                  80                  85                  90
```

```
gtc ggc gtc gcg acg ccg aag gcg aac cgc tgg tgg tgg gac gtt ctg     1060
Val Gly Val Ala Thr Pro Lys Ala Asn Arg Trp Trp Trp Asp Val Leu
                 95                 100                 105
```

```
gcc cgt gga cag cgg tcg gag tac gcc gac tac ttc gac atc gac tgg     1108
Ala Arg Gly Gln Arg Ser Glu Tyr Ala Asp Tyr Phe Asp Ile Asp Trp
                110                 115                 120
```

```
gag ttc ggc ggc ggc agg ctg cgc ctg ccc gtg ctc ggc gac ggc ccc     1156
Glu Phe Gly Gly Gly Arg Leu Arg Leu Pro Val Leu Gly Asp Gly Pro
                125                 130                 135
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```
gac gag ctc gac gcg ctg aga gtg gat ggc gac gag ctc gtc tac tac     1204
Asp Glu Leu Asp Ala Leu Arg Val Asp Gly Asp Glu Leu Val Tyr Tyr
                140                 145                 150
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```
gag cac cgc ttc ccg atc gcc gag ggc acc ggc ggc ggc acc ccg cgc     1252
Glu His Arg Phe Pro Ile Ala Glu Gly Thr Gly Gly Gly Thr Pro Arg
155                 160                 165                 170
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```
gag gtg cac gac cgg cag cac tac gag ctg atg tcg tgg cgg cgg gcc      1300
Glu Val His Asp Arg Gln His Tyr Glu Leu Met Ser Trp Arg Arg Ala
            175                 180                 185

gac cac gac ctc aac tac cgc cgc ttc ttc gcc gtg aac acg ctc gcc      1348
Asp His Asp Leu Asn Tyr Arg Arg Phe Phe Ala Val Asn Thr Leu Ala
            190                 195                 200

gcc gta cgc gtc gaa gac ccg cgc gtg ttc gac gac acc cac cgc gag      1396
Ala Val Arg Val Glu Asp Pro Arg Val Phe Asp Asp Thr His Arg Glu
            205                 210                 215

atc ggc cgc tgg atc gcc gag ggc ctc gtc gac ggc ctg cgc gtc gac      1444
Ile Gly Arg Trp Ile Ala Glu Gly Leu Val Asp Gly Leu Arg Val Asp
            220                 225                 230

cac ccc gac ggg ctg cgc gcc ccc ggc gac tac ctg cgc cgt ctc gcc      1492
His Pro Asp Gly Leu Arg Ala Pro Gly Asp Tyr Leu Arg Arg Leu Ala
235                     240                 245                 250

gag ctc gcc caa ggc agg ccg atc tgg gtc gag aag atc atc gag ggc      1540
Glu Leu Ala Gln Gly Arg Pro Ile Trp Val Glu Lys Ile Ile Glu Gly
            255                 260                 265

gac gag cgg atg ccc ccg cag tgg ccc atc gcc ggc acc acc ggc tac      1588
Asp Glu Arg Met Pro Pro Gln Trp Pro Ile Ala Gly Thr Thr Gly Tyr
            270                 275                 280

gac gcg ctg gcc ggg atc gac cgg gtg ctc gtc gac ccc gcg ggc gag      1636
Asp Ala Leu Ala Gly Ile Asp Arg Val Leu Val Asp Pro Ala Gly Glu
            285                 290                 295

cat ccg ctc acc cag atc gtc gac gag gcg gca ggc agc ccc cgg cgc      1684
His Pro Leu Thr Gln Ile Val Asp Glu Ala Ala Gly Ser Pro Arg Arg
            300                 305                 310

tgg gcc gag ctg gtt ccc gag cgc aag cgg gcc gtc gcc cgc ggc atc      1732
Trp Ala Glu Leu Val Pro Glu Arg Lys Arg Ala Val Ala Arg Gly Ile
315                     320                 325                 330

ctg aac tcc gag atc cgc cgc gtc gcc cgc gaa ctc gga gag gtc gcc      1780
Leu Asn Ser Glu Ile Arg Arg Val Ala Arg Glu Leu Gly Glu Val Ala
            335                 340                 345

ggc gac gtc gaa gac gcg ctc gtc gag atc gcc gcc gcc ctg tcc gtc      1828
Gly Asp Val Glu Asp Ala Leu Val Glu Ile Ala Ala Ala Leu Ser Val
            350                 355                 360

tac cgc agc tac ctg ccg ttc ggg cgc gag cac ctc gac gaa gcc gtg      1876
Tyr Arg Ser Tyr Leu Pro Phe Gly Arg Glu His Leu Asp Glu Ala Val
            365                 370                 375

gcc gcc gcg cag gcc gca gcc ccc cag ctc gag gcc gac ctc gcc gcc      1924
Ala Ala Ala Gln Ala Ala Ala Pro Gln Leu Glu Ala Asp Leu Ala Ala
            380                 385                 390

gtc ggc gca gcg ctc gcc gac ccg ggc aac ccc gcc gcg ctc cgc ttc      1972
Val Gly Ala Ala Leu Ala Asp Pro Gly Asn Pro Ala Ala Leu Arg Phe
395                     400                 405                 410

cag cag acc agc ggc atg atc atg gcc aag ggc gtc gag gac aac gcg      2020
```

```
Gln Gln Thr Ser Gly Met Ile Met Ala Lys Gly Val Glu Asp Asn Ala
            415             420                 425

ttc tac cgc tac ccc cgg ctc acc tcg ctg acc gag gtc ggg gga gac    2068
Phe Tyr Arg Tyr Pro Arg Leu Thr Ser Leu Thr Glu Val Gly Gly Asp
            430             435                 440

ccg agc ctg ttc gcg atc gac gcg gcc gcc ttc cac gcg gcg cag cgc    2116
Pro Ser Leu Phe Ala Ile Asp Ala Ala Ala Phe His Ala Ala Gln Arg
            445             450                 455

gac cgc gcc gcc cgg ctg ccc gag tcg atg acg acg ctg acc acc cac    2164
Asp Arg Ala Ala Arg Leu Pro Glu Ser Met Thr Thr Leu Thr Thr His
    460             465                 470

gac acc aag cgc agc gaa gac acc cgg gcg cgg atc acc gcg ctc gcc    2212
Asp Thr Lys Arg Ser Glu Asp Thr Arg Ala Arg Ile Thr Ala Leu Ala
475             480                 485                 490

gag gcc ccc gaa cgc tgg cgg cgc ttc ctg acc gag gtc ggc ggg ctc    2260
Glu Ala Pro Glu Arg Trp Arg Arg Phe Leu Thr Glu Val Gly Gly Leu
            495                 500                 505

atc gga acg ggc gac cgg gtg ctg gag aac ctg atc tgg cag gcg atc    2308
Ile Gly Thr Gly Asp Arg Val Leu Glu Asn Leu Ile Trp Gln Ala Ile
            510                 515                 520

gtc ggc gcg tgg ccg gcg agc cgg gag cgg ctc gag gcc tac gcg ctg    2356
Val Gly Ala Trp Pro Ala Ser Arg Glu Arg Leu Glu Ala Tyr Ala Leu
            525                 530                 535

aag gcc gcg cgc gaa gcc ggc gag tcg acc gac tgg atc gac ggc gac    2404
Lys Ala Ala Arg Glu Ala Gly Glu Ser Thr Asp Trp Ile Asp Gly Asp
    540                 545                 550

ccc gcg ttc gaa gag cgg ctg acc cgc ctg gtc acg gtc gcc gtc gag    2452
Pro Ala Phe Glu Glu Arg Leu Thr Arg Leu Val Thr Val Ala Val Glu
555                 560                 565                 570

gag ccg ctc gtg cac gag ctg ctc gag cgg ctc gtc gac gag ctg acg    2500
Glu Pro Leu Val His Glu Leu Leu Glu Arg Leu Val Asp Glu Leu Thr
            575                 580                 585

gcg gcc ggg tac tcc aac ggc ctc gcg gcg aag ctg ctg cag ctg ctc    2548
Ala Ala Gly Tyr Ser Asn Gly Leu Ala Ala Lys Leu Leu Gln Leu Leu
            590                 595                 600

gcc ccc gga acc ccc gac gtg tac cag ggc acg gaa cgc tgg gac cgg    2596
Ala Pro Gly Thr Pro Asp Val Tyr Gln Gly Thr Glu Arg Trp Asp Arg
            605                 610                 615

tcg ctg gtg gac ccg gac aac cgt cgc ccc gtg gat ttc gcc gcg gca    2644
Ser Leu Val Asp Pro Asp Asn Arg Arg Pro Val Asp Phe Ala Ala Ala
            620             625                 630

tcc gag ctg ctc gac cgc ctc gac ggc ggc tgg cgg ccg ccc gtc gac    2692
Ser Glu Leu Leu Asp Arg Leu Asp Gly Gly Trp Arg Pro Pro Val Asp
635                 640                 645                 650

gag acc ggc gcg gtc aag acg ctc gtc gtc tcc cgc gcg ctg cgg ctg    2740
Glu Thr Gly Ala Val Lys Thr Leu Val Val Ser Arg Ala Leu Arg Leu
```

```
cgc cgc gac cgg ccc gag ctg ttc acc gcg tac cac ccg gtc acg gcg   2788
Arg Arg Asp Arg Pro Glu Leu Phe Thr Ala Tyr His Pro Val Thr Ala
        670                 675                 680

cgc ggc gcg cag gcc gag cac ctg atc ggc ttc gac cgc ggc ggc gcg   2836
Arg Gly Ala Gln Ala Glu His Leu Ile Gly Phe Asp Arg Gly Gly Ala
        685                 690                 695

atc gcc ctg gcc acc cgc ctg ccg ctc ggc ctc gcc gcc gca ggc ggc   2884
Ile Ala Leu Ala Thr Arg Leu Pro Leu Gly Leu Ala Ala Ala Gly Gly
    700                 705                 710

tgg ggc gac acg gtc gtc gac gtc ggc gag cgg agc ctg cgc gac gag   2932
Trp Gly Asp Thr Val Val Asp Val Gly Glu Arg Ser Leu Arg Asp Glu
715                 720                 725                 730

ctg acc ggc cgc gag gcc cgc gga gcg gcg cgc gtg gcc gag ttg ttc   2980
Leu Thr Gly Arg Glu Ala Arg Gly Ala Ala Arg Val Ala Glu Leu Phe
            735                 740                 745

gcc gac tac ccc gtc gcc ctg ctg gtg gag aca tgaaccgacg attcccggtc 3033
Ala Asp Tyr Pro Val Ala Leu Leu Val Glu Thr
            750                 755
```

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```
tgggcgcccc aggccgcgca ggtgacgctc gtcgtgggcc aaggccgcgc cgaactcccg 3093
ctgacccgcg acgagaacgg atggtgggct cttcagcagc cgtgggacgg cggccccgac 3153
ctcgtcgact acggctacct cgtcgacggc aagggcccct tcgccgaccc gcggtcgctg 3213
cggcagccgc gcggcgtgca cgagctcggc cgcgaattc                        3252
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<210> 20
<211> 26
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:SYNTHETIC

<400> 20
atgcccgcca gtacctaccg ccttca                                        26


<210> 21
<211> 25
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:SYNTHETIC

<400> 21
tcatgtctcc accagcaggg cgacg                                         25


<210> 22
<211> 50
<212> DNA
<213> Artificial Sequence
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<220>
<223> Description of Artificial Sequence:SYNTHETIC

<400> 22
aattctttt taataaaatc aggaggaatc tagatgttta ctagtctgca   50

<210> 23
<211> 42
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:SYNTHETIC

<400> 23
gactagtaaa catctagatt cctcctgatt ttattaaaaa ag   42

<210> 24
<211> 33
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:SYNTHETIC

<400> 24
aaatctagat gcccgccagt acctaccgcc ttc   33

<210> 25
<211> 33
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:SYNTHETIC

<400> 25
aaaactagtt tatcatgtct ccaccagcag ggc   33

<210> 26
<211> 22
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:SYNTHETIC

<400> 26
atcggtgatg tcggcgatat ag   22

<210> 27
<211> 29
<212> DNA
<213> Artificial Sequence

<220>

<400> 27
gtactggcgg gcatattttt tcctcctga   29

<210> 28
<211> 31
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:SYNTHETIC

<400> 28
aatcaggagg aaaaaatatg cccgccagta c   31

<210> 29
<211> 22
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:SYNTHETIC

<400> 29
tcgacgatct gggtgagcgg at   22

<210> 30
<211> 22
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:SYNTHETIC

<400> 30
tcgacgagca cccggtcgat cc   22

<210> 31
<211> 26
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:SYNTHETIC

<220>
<223> n at position 18 is a, c, g, or t.

<400> 31
cartgggayg aygaygtnca ycaygc   26

<210> 32
<211> 2218
<212> DNA

<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:SYNTHETIC

<220>
<221> CDS
<222> (477)..(2201)

<220>
<221> 3'UTR
<222> (2202)..(2218)

<400> 33
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ctgcagctgc tcgcccccgg aacccccgac gtgtaccagg gcacggaacg ctgggaccgg    60

tcgctggtgg acccggacaa ccgtcgcccc gtggatttcg ccgcggcatc cgagctgctc   120

gaccgcctcg acggcggctg gcggccgccc gtcgacgaga ccggcgcggt caagacgctc   180

gtcgtctccc gcgcgctgcg gctgcgccgc gaccggcccg agctgttcac cgcgtaccac   240

ccggtcacgg cgcgcggcgc gcaggccgag cacctgatcg gcttcgaccg cggcggcgcg   300

atcgccctgg ccacccgcct gccgctcggc ctcgccgccg caggcggctg gggcgacacg   360

gtcgtcgacg tcggcgagcg gagcctgcgc gacgagctga ccggccgcga ggcccgcgga   420

gcggcgcgcg tggccgagtt gttcgccgac tacccccgtcg ccctgctggt ggagac atg   479
                                                              Met
                                                                1
```
```
aac cga cga ttc ccg gtc tgg gcg ccc cag gcc gcg cag gtg acg ctc   527
Asn Arg Arg Phe Pro Val Trp Ala Pro Gln Ala Ala Gln Val Thr Leu
              5                  10                  15

gtc gtg ggc caa ggc cgc gcc gaa ctc ccg ctg acc cgc gac gag aac   575
Val Val Gly Gln Gly Arg Ala Glu Leu Pro Leu Thr Arg Asp Glu Asn
            20                  25                  30

gga tgg tgg gct ctt cag cag ccg tgg gac ggc ggc ccc gac ctc gtc   623
Gly Trp Trp Ala Leu Gln Gln Pro Trp Asp Gly Gly Pro Asp Leu Val
        35                  40                  45

gac tac ggc tac ctc gtc gac ggc aag ggc ccc ttc gcc gac ccg cgg   671
Asp Tyr Gly Tyr Leu Val Asp Gly Lys Gly Pro Phe Ala Asp Pro Arg
    50                  55                  60                  65

tcg ctg cgg cag ccg cgc ggc gtg cac gag ctc ggc cgc gaa ttc gac   719
Ser Leu Arg Gln Pro Arg Gly Val His Glu Leu Gly Arg Glu Phe Asp
                70                  75                  80

ccc gcc cgc tac gcg tgg ggc gac gac gga tgg cgc ggc cga gac ctc   767
Pro Ala Arg Tyr Ala Trp Gly Asp Asp Gly Trp Arg Gly Arg Asp Leu
            85                  90                  95

acc gga gcc gtg atc tac gaa ctg cac gtc ggc acc ttc acc cct gag   815
Thr Gly Ala Val Ile Tyr Glu Leu His Val Gly Thr Phe Thr Pro Glu
           100                 105                 110

gga acg ctg gac agc gcc atc cgt cgc ctc gac cac ctg gtg cgc ctc   863
```

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Gly Thr Leu Asp Ser Ala Ile Arg Arg Leu Asp His Leu Val Arg Leu
    115                 120                 125

ggc gtc gac gcg gtc gag ctg ctg ccc gtc aac gcg ttc aac ggc acc    911
Gly Val Asp Ala Val Glu Leu Leu Pro Val Asn Ala Phe Asn Gly Thr
130                 135                 140                 145

cac ggc tgg ggc tac gac ggg gtg ctc tgg tac gcg gtg cac gag ccc    959
His Gly Trp Gly Tyr Asp Gly Val Leu Trp Tyr Ala Val His Glu Pro
                    150                 155                 160

tac ggc ggc ccg gag gcg tac cag cgc ttc gtc gac gcc tgc cac gcc    1007
Tyr Gly Gly Pro Glu Ala Tyr Gln Arg Phe Val Asp Ala Cys His Ala
                165                 170                 175

cgc ggc ctc gcc gtc gtg cag gac gtc gtc tac aac cac ctg ggc ccg    1055
Arg Gly Leu Ala Val Val Gln Asp Val Val Tyr Asn His Leu Gly Pro
            180                 185                 190

agc ggc aac cac ctg ccc gac ttc ggc ccc tac ctc ggg tcg ggc gcc    1103
Ser Gly Asn His Leu Pro Asp Phe Gly Pro Tyr Leu Gly Ser Gly Ala
        195                 200                 205

gcc aac acc tgg ggc gac gcg ctg aac ctc gac ggg ccg ctc tcc gac    1151
Ala Asn Thr Trp Gly Asp Ala Leu Asn Leu Asp Gly Pro Leu Ser Asp
210                 215                 220                 225

gag gtg cgg cgg tac atc atc gac aac gcg gtg tac tgg ctg cgc gac    1199
Glu Val Arg Arg Tyr Ile Ile Asp Asn Ala Val Tyr Trp Leu Arg Asp
                230                 235                 240

atg cac gcc gac ggg ctg cgg ctc gac gcc gtg cac gcg ctg cgc gac    1247
Met His Ala Asp Gly Leu Arg Leu Asp Ala Val His Ala Leu Arg Asp
            245                 250                 255

gcc cgc gcg ctg cac ctg ctc gaa gag ctc gcc gcc cgc gtc gac gag    1295
Ala Arg Ala Leu His Leu Leu Glu Glu Leu Ala Ala Arg Val Asp Glu
            260                 265                 270

ctg gcg ggc gag ctc ggc cgg ccg ctg acg ctc atc gcc gag agc gac    1343
Leu Ala Gly Glu Leu Gly Arg Pro Leu Thr Leu Ile Ala Glu Ser Asp
        275                 280                 285

ctg aac gac ccg aag ctg atc cgc tcc cgc gcg gcg cac ggc tac ggc    1391
Leu Asn Asp Pro Lys Leu Ile Arg Ser Arg Ala Ala His Gly Tyr Gly
290                 295                 300                 305

ctc gac gcc cag tgg gac gac gac gtg cac cac gcg gtg cac gcc aac    1439
Leu Asp Ala Gln Trp Asp Asp Asp Val His His Ala Val His Ala Asn
                310                 315                 320

gtg acc ggc gag acc gtc ggc tac tac gcc gac ttc ggc ggg ctc ggc    1487
Val Thr Gly Glu Thr Val Gly Tyr Tyr Ala Asp Phe Gly Gly Leu Gly
                325                 330                 335

gcc ctc gtc aag gtg ttc cag cgc ggc tgg ttc cac gac ggc acc tgg    1535
Ala Leu Val Lys Val Phe Gln Arg Gly Trp Phe His Asp Gly Thr Trp
            340                 345                 350

tcg agc ttc cgc gag cgg cac cac ggc cgg ccg ctc gac ccc gac atc    1583
Ser Ser Phe Arg Glu Arg His His Gly Arg Pro Leu Asp Pro Asp Ile
```

```
ccg ttc cgc cgg ctc gtc gcc ttc gcg cag gat cac gac cag gtc ggc    1631
Pro Phe Arg Arg Leu Val Ala Phe Ala Gln Asp His Asp Gln Val Gly
370            375            380            385

aac cga gcg gtc ggc gac cgc atg tcg gcg cag gtc ggc gag ggt tcg    1679
Asn Arg Ala Val Gly Asp Arg Met Ser Ala Gln Val Gly Glu Gly Ser
               390            395            400

ctc gcc gcc gcg gcg gcg ctc gtg ctg ctc ggc ccg ttc acc ccg atg    1727
Leu Ala Ala Ala Ala Ala Leu Val Leu Leu Gly Pro Phe Thr Pro Met
           405            410            415

ctg ttc atg ggc gag gag tgg ggc gcg cgc acc ccg tgg cag ttc ttc    1775
Leu Phe Met Gly Glu Glu Trp Gly Ala Arg Thr Pro Trp Gln Phe Phe
           420            425            430

acc tcc cac ccc gag ccc gag ctg ggg gag gcg acg gcg cgc ggg cgc    1823
Thr Ser His Pro Glu Pro Glu Leu Gly Glu Ala Thr Ala Arg Gly Arg
       435            440            445

atc gcc gag ttc gcc cgc atg ggc tgg gac ccg gca gtc gtg ccc gac    1871
Ile Ala Glu Phe Ala Arg Met Gly Trp Asp Pro Ala Val Val Pro Asp
450            455            460            465

ccg cag gac ccg gcc acc ttc gcc cgc tcg cac ctg gac tgg tcc gag    1919
Pro Gln Asp Pro Ala Thr Phe Ala Arg Ser His Leu Asp Trp Ser Glu
               470            475            480

ccc gag cgg gaa ccg cac gcg ggc ctg ctc gcc ttc tac acc gac ctg    1967
Pro Glu Arg Glu Pro His Ala Gly Leu Leu Ala Phe Tyr Thr Asp Leu
           485            490            495

atc gcg ctg cgg cgc gag ctg ccg gtc gat gcg ccg gcg cgc gag gtg    2015
Ile Ala Leu Arg Arg Glu Leu Pro Val Asp Ala Pro Ala Arg Glu Val
           500            505            510

gat gcc gac gag gcg cgc ggc gtc ttc gcg ttc agc cgc ggc ccg ctg    2063
Asp Ala Asp Glu Ala Arg Gly Val Phe Ala Phe Ser Arg Gly Pro Leu
       515            520            525

cgg gtc acg gtc gcg ctg cgc ccc gga ccg gtc ggg gtg ccc gag cac    2111
Arg Val Thr Val Ala Leu Arg Pro Gly Pro Val Gly Val Pro Glu His
530            535            540            545

ggg ggc ctc gtg ctc gcc tac ggc gag gtg cgc gcc ggc gcc gcc gga    2159
Gly Gly Leu Val Leu Ala Tyr Gly Glu Val Arg Ala Gly Ala Ala Gly
               550            555            560

ctg cac ctc gac ggg ccg gga gcc gcg atc gtg cgc ctc gag          2201
Leu His Leu Asp Gly Pro Gly Ala Ala Ile Val Arg Leu Glu
           565            570            575

tgacgcggct gggtacc                                               2218
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<210> 33
<211> 25
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:SYNTHETIC

<400> 33
atgaaccgac gattcccggt ctggg   25

<210> 34
<211> 25
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:SYNTHETIC

<400> 34
tcactcgagg cgcacgatcg cggct   25

<210> 35
<211> 36
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:SYNTHETIC

<400> 35
aaatctagat gaaccgacga ttcccggtct gggcgc   36

<210> 36
<211> 36
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:SYNTHETIC

<400> 36
aaaactagtt tatcactcga ggcgcacgat cgcggc   36

<210> 37
<211> 28
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:SYNTHETIC

<400> 37
atcgtcggtt catatttttt cctcctga   28

<210> 38
<211> 28
<212> DNA
<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence:SYNTHETIC

<400> 38
aatcaggagg aaaaaatatg aaccgacg   28

<210> 39
<211> 22
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:SYNTHETIC

<400> 39
aggtggttgt agacgacgtc ct   22

20